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ABSTRACT

Despite great development in computer technologies being used for open learning enrollments, it is still likely that the majority of student-academic staff contact at Australian universities takes place in a lecture theater or classroom. The students' contact with any form of educational technology is more likely to be with technology in a lecture theater than it is in a computer laboratory. It is important that those in the educational technology field do not lose sight of the importance of providing a technologically rich environment in which academic staff and students will continue to have lectures, tutorials and seminars on campus. The 1990s have seen a rapid development of various communication technologies, a great rise in undergraduate student numbers with a consequent rise in the size of undergraduate classes and a less than proportionate rise in general staff numbers. This paper outlines how Queensland University of Technology (QUT) has established electronic classrooms and presents data on how staff and students use the technology that is being installed in the media equipped lecture theaters (MELTs) at QUT. A survey of staff use of the technology over an 18-month period showed that younger staff seemed to adapt their teaching strategies to make use of the new technology, while many of the older staff (more than 10 years teaching experience) remained resistant to change, despite being faced with considerably larger classes. Much more attention must be given to staff training in the effective use of the technology for large group teaching, since it does not appear that staff will automatically adopt new teaching strategies that make use of the available technology. (SWC)

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Electronic classrooms and lecture theatres: Design and use factors in the age of the mass lecture

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The most recent definition of instructional technology produced by the Association for Educational Communications and Technology says:

> Instructional technology is the theory and practice of design, development, utilization, management and evaluation of processes and resources for learning [1].

While this is a very broad definition it certainly encompasses the issues which we are dealing with in this paper. As Michael Albright has recently said when discussing the important differences between information technology and instructional technology: "Remember that setting is an important concern of instructional technology, including such environmental conditions as climate control, quality of seating, upkeep of the chalkboards and marker boards, and the other things that typically drive faculties crazy. As instructional technologists, our turf begins at the classroom wall." [2] So while the last ten years has seen a great development of computer technologies being used for student instruction at universities and a variety of communication technologies being used for open learning enrolments, it is still likely that for the majority of students at Australian universities, the majority of their contact with academic staff takes place in a lecture theatre or classroom. The students contact with any form of educational technology is more likely to be with technology in a lecture theatre than it is in a computer laboratory. While this generalisation is rapidly changing, we feel it is important that those in the educational technology field do not lose sight of the importance of providing a technologically rich environment in which academic staff and students will continue to have lectures, tutorials and seminars on campus.

Designs for the '90's

The 1990's has seen a rapid development of various communication technologies, a great rise in undergraduate student numbers with a consequent rapid rise in the size of many undergraduate classes and a less than proportionate rise in general staff numbers as the universities struggle to make the efficiencies pressed on them by Canberra. The characteristics of the undergraduate student have also changed, reflecting the wider changes in the society, suggesting academic staff adopt teaching styles more in keeping with the experience, expectations and knowledge of today's undergraduates.

With the rise in student numbers at Australian universities over the last ten years, there has also been an ongoing process of universities constructing new teaching spaces, often including quite large lecture theatres, while older buildings on some campuses are being refurbished.

The extent to which institutions will provide appropriate budgets to allow this development to occur adequately will also depend on many factors, such as the importance placed on teaching in the institution and the skill and determination of the staff charged with providing these facilities. The installation of electronic classrooms and lecture theatres is a trend that is strongly under way in some overseas countries, particularly the USA. [3.4.5.] So far there has been little research into the effectiveness of these electronic classrooms either from the point of view of changing large group

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teaching strategies or the effect on student learning which should be the final goal of all such applications of technology to the teaching process.

This paper is therefore divided into two main parts. We will outline for you how QUT has gone about providing electronic classrooms and secondly, we will present some data on how staff and students are using the technology that is now being installed in the media equipped lecture theatres (MELT's) at QUT.

The QUT approach

QUT places a high priority on teaching as one of its aims is to be the best teaching university for undergraduates' education in Australia.[6] Some external evidence for this was demonstrated when, in 1993, QUT was awarded the inaugural University of the Year Award by the *Good University Guide* for the quality of innovative teaching, support for undergraduates and the balance between intellectual challenge and practical skills in its courses. Further evidence of QUT's interest in promoting good quality undergraduate teaching can be seen in the internally funded small, large and infrastructure teaching grants which have been in place for a number of years and which, in 1995 totalled $870,000. Many of these grants have been for the development of teaching innovations related to the use of instructional technology.

In support of this mission of sustaining high quality undergraduate teaching since 1992, QUT has been funding a program of installing 'smart' lecture theatres, or as we now call them MELT's, (Media equipped lecture theatres), in new buildings and in refurbished theatres. A significant component of the funds for the refurbishment of existing teaching space has come from allocations to the Department of Audiovisual Services out of the Quality funds that have come to QUT. In 1993, the Audiovisual Services' share of these funds for the MELT project was $312,000 and in 1994, $230,000. The Computing Services Department has also been funding the connection of existing lecture theatres to the computing network, while in one year, a small sum came from the QUT Long Term Information Technology Plan funds, to buy some AMX theatre control equipment for a couple of theatres.

The first theatres to be equipped with any type of theatre control system were six lecture theatres constructed in a new 12-storey Information Technology and Engineering (ITE) building on the Gardens Point campus. This building was under construction when I took up my position at QUT in 1991.

Although I was asked to provide advice on the audiovisual fitout of the lecture theatres and classrooms, of which there were about twelve, there was little we could do to fix the basic design of the lecture theatres. However, the external contractor did quote to fit AMX button lecterns and we did manage to get enough money for four video projectors. This initial building set the model.

This section of the presentation will describe our goals and attempts to achieve them.

The Ideal Theatre

If we could offer every facility users have requested and resolve every criticism made, our ideal theatre would have the following characteristics:

1. Perfect projected images which everyone in the theatre can see perfectly regardless of lighting conditions.
2. Perfect acoustics so everyone can hear perfectly.
3. Access to every possible media source.
4. Invisible technology which requires no expertise to use — and never fails!
5. Infinitely variable size and seating arrangements to adapt to differing needs and personal teaching style of the lecturer.
6. Unlimited whiteboard/chalkboard space which can be clearly seen by all students.
7. Unlimited support staff who arrive within ten milliseconds (twenty milliseconds after hours!)
8. Zero cost.

The Reality

Unfortunately, none of the above ideals are achievable and at best we can only offer a compromise. Our challenge as system designers is to achieve the best compromise. Some aspects are well beyond our control, but we can influence some. In particular it is our duty to:

- ensure the correct technology is installed
- modify the physical environment to allow the technology to function properly
- train the users to use the technology effectively
- keep the technology up-to-date

Let us explore some of these points in more detail.

Correct Technology — It is vital that any technology installed in a theatre matches the *real* needs rather than fit within a pre-determined budget. For example, when selecting a data projector for a large lecture theatre, the end result must be a clearly visible image for all students. The theatre size dictates the image size, which dictates the projector's brightness requirements, which in turn determines the cost. Using the 'what can we afford? approach, will almost invariably result in an installation which does not satisfy the basic need.

Physical Environment — (Physical environment refers to lighting, acoustics, ventilation and furnishings.) The physical environment is the single most important factor governing the success or failure of a theatre to fulfil its intended role. It is also the area of responsibility which varies most widely between institutions.

A lecture theatre is a presentation venue. A presentation involves a visual and an audible component, both of which must be conveyed clearly to the audience (students). The actual theatre environment has a significant influence on the quality of the information received by the individual students. Apart from the correct technology, we need:

- Good acoustics — low reverberation levels and maximum isolation from external noise
- Lighting configuration and control optimised to suit presentation and projection needs
- Unobstructed sightlines to all screens and to the presenter
- Sufficient screens and whiteboards/chalkboards to display visuals
- Comfortable environment for students — adequate ventilation and temperature control, good seats and adequate note space

The design process must consider all of the above, but some are outside the traditional scope (and control) of a media or audiovisual section. Regardless of organisational structure or internal politics, it is vital that all these requirements be strongly impressed upon the theatre designers — it is surprising what will be overlooked if *anything* is assumed! For a new theatre, it is possible to satisfy all the goals above. For refurbishment projects, the scope for optimising the environment will vary — but it is important to strive for the best compromise. I would like to discuss some aspects of the physical environment in more detail:

Lighting — There are some 'golden rules' which should be obeyed when designing or specifying lighting systems for a lecture theatre:

- Lighting should be configurable to suit varying needs in the theatre — from bright, omni-directional lighting for examinations to zoned, low level down-lighting for projection.
- Lighting for projection must be 'vertical' — ie. there should be a minimum of horizontal lighting which will wash onto projection screens.
- There must be sufficient light for students to take notes, but a minimum of light washing the screen
- Lighting should be zoned to permit fine control of levels in various parts of the theatre

From our experience with many theatres (and electrical consultants), we have settled on a preferred lighting configuration which may or may not apply elsewhere. At QUT we now specify two lighting systems — fluorescent for general purpose lighting and dimmable incandescent for controlled lighting for presentations.

Theatre shape -The optimum design for a presentation theatre roughly adheres to the following rules:

- The optimum floor plan is *rectangular* and the length approximates 1.5 to 2 times the width.
- The ceiling height at the display wall will be at least one-sixth the length of the theatre plus 1.8 metres. (Example: For a theatre 18m long, the ceiling should be at least 4.8 metres high.)

- The floor will be tiered to permit good sightlines for all students. A typical rake of 15 degrees is desirable.

Case Study: QUT's Media equipped lecture theatres

We cannot provide users with the ideal theatre mentioned above, but our challenge is to provide the best compromise. QUT experimented with a number of designs, some of which failed and some of which worked quite well. A brief description of some of QUT's successes and failures follows.

Successes

Our first objective was to create a consistent user interface which offered the lecturer control of all theatre facilities — not just AV controls — from the lecturing position. We met this need with AMX control equipment which allowed us to create a standard interface on a standard control panel. A lecturer can be time-tabled into a variety of theatres, but the user interface is virtually identical — no need to learn where the switches and controls are for each theatre. I would rate this standardisation of controls (and technology behind it) as one of our major achievements in lecture theatres.

User feedback indicated some dissatisfaction with the Lectrum lecterns — lack of note space and no room for a laptop or notebook computer — so we experimented with custom benches and control consoles. We tried a number of schemes and found the most successful method was to house most of the AV equipment in racking in the bench and to house monitors and the AMX control panel in a console. This places all the AV technology within convenient reach of the lecturer.

One piece of technology which caused (and is still causing) some heartache was the computer. Eventually we decided to 'take the plunge and install permanent PC's in theatres. Despite some frustration with tampering and software corruption, the inclusion has been well justified and appreciated by users as illustrated by usage data gathered by the AMX system. The benefits far outweigh the drawbacks. I would rate the inclusion of PC's in theatres as a success.

Another success was the installation of wireless PC mice in theatres. This allows the lecturer to control computer presentations away from the lectern. It is standard equipment in all PC-equipped theatres and very popular! Finally, I rate our logging of actual technology usage in theatres as a successful innovation. Gathering real usage data (as opposed to relying on surveys) gives a powerful tool for decision making and planning. For example, we can accurately state that the average use of Photo CD players in 1995 was less than 20 minutes per theatre for the entire year, and therefore we can justify no longer installing them.

Failures and dead-ends

In 1992/3 we attempted to design a very compact lectern which incorporated Touchscreen control panel and display for the computer and video sources.

The space and size requirement dictated an active matrix LCD flat screen display. Despite much experimentation, we were unable to source technology which met our needs. The LCD in the lectern was abandoned and we installed a multi-sync monitor on a mobile stand near the lectern. We were defeated by available technology!!

Two later attempts to use one monitor for both PC and video also proved unsatisfactory. One trial converted the VGA signal to PAL video and fed to a video monitor mounted in the lecturer's console. The low-cost scan converter we used created a flickering, poor resolution picture and was limited to 640 x 480 VGA thereby restricting the PC to VGA resolution. The other attempt used a video capture card in the PC to create a video window on the (S-VGA) PC monitor. However, this proved troublesome because the software was a little unstable and required the lecturer to be conversant with Windows to display a video image. Both ideas have now been scrapped in favour of separate monitors for PC and video.

A particularly spectacular failure occurred in a brand new 430-seat theatre in 1993. Our advice that a conventional 3-tube data projector would be unsatisfactory was ignored. The end product was a new and expensive facility which could not perform its primary role as a presentation venue. Loud protests from users soon produced the desired results — the money for the expensive 'light valve' projector we originally specified suddenly appeared!! Happily, our recommendations are now taken seriously.

Assessing the MELT effectiveness

A feature of QUT is the existence of a series of academic groups know as Teaching, Reflection and Collaboration groups (TRAC) under the umbrella of the Academic Staff Development Unit (ASCU.) One of these groups was formed by staff interested in teaching to large classes and the Director of Audiovisual Services joined this group which, in 1994, obtained a grant to do a number of things, one of which was to survey staff and students about their experiences of teaching and learning in large classes at QUT. We have subsequently continued to survey staff on their use of the MELT's whenever a new MELT comes into use and now have data from mid-1994. The following analysis is derived from three separate surveys of staff who had taught in media equipped lecture theatres at QUT. The figures for 1994 were taken from a questionnaire sent to all academic staff from the Teaching and Learning in Large Classes (TALLC) group. In this survey, staff were asked to indicate if they had taught in one of the lecture theatres that had been equipped with AMX theatre control systems and data projectors. The figures below are based on the responses from staff who had taught in one of these MELT's, not from the general reply to the questionnaire. There were 30 responses to the mid '95 survey and 23 to the end of '95 survey. In mid '95 six theatres were surveyed and at the end of '95 another series of five theatres surveyed.

Technology usage

Items 9 to 23 asked staff to indicate the frequency of use of the equipment installed in the nominated theatres and also rate the items perceived usefulness.

Item	Response	End 1995	Mid 1995	1994
Item 9 — Blackboard/whiteboard	Not available	4.3%	3.3%	-
	Never used	21.7%	6.7%	3.8%
	Used occasionally	34.8%	40%	27.8%
	Used frequently	17.4%	13.3%	34.6%
	Always use	21.7%	33.3%	33.6%

Comment: It would seem that staff teaching in the 5 nominated theatres in 1995 are using the board less than staff in 1994. At the end of 1995 there was a significant decline in the use of the boards. The 'never use' response is now the same as the 'always use' response which marks a change from the 2 previous surveys.

Item	Response	End 1995	Mid 1995	1994
Item 10 — Overhead projector	Not available	30.4%	-	-
	Never use	8.7%	3.3%	-
	Used occasionally	4.3%	13.3%	3.7%
	Used frequently	13%	16.7%	38.6%
	Always used	43.5%	66.7%	57.54%

Comment: The OHP is by far the most frequently used piece of AV equipment in lecture theatres but these results would tend to suggest that some staff are using the OHP less frequently than they were in 1994. The high percentage for 'not available' at the end of 1995 is a reflection of the fact that in 3 of the 5 theatres surveyed the OHP had been replaced by a visualiser.

Item	Response	End 1995	Mid 1995	1994
Item 11 — Electronic visualiser	Not available	17.4%	4.8%	-
	Never used	13.0%	57.1%	51.7%
	Used occasionally	21.7%	14.3%	22.4%
	Used frequently	13.0%	4.8%	13.7%
	Always used	34.8%	19%	12%

Comment: This device is fitted permanently to only one of the 'smart' theatres surveyed in 1995 and was installed in only two of the theatres surveyed in 1994. At the end of 1995 3 of the 5 theatres in the survey had a visualiser installed instead of an OHP.

In both 1994 and 1995 a high percentage of staff failed to complete responses to this item thus the accuracy of the results is open to question.

Item	Response	End 1995	Mid 1995	1994
Item 12 — VHS Videotape recorder	Not available	4.3%	-	-
	Never used	47.8%	29.6%	23.9%
	Used occasionally	30.4%	29.6%	42.39%
	Used frequently	17.4%	37%	26%
	Always used	-	3.7%	7.6%

Comment: It would seem that the use of video material has increased slightly since 1994 in mid 1995 although a slightly higher percentage of staff in both 1995 surveys claim to never use video material than in the 1994.

Item	Response	End 1995	Mid 1995	1994
Item 15 — Personal computer	Not available	8.7%	3.4%	-
	Never used	47.8%	48.3%	47.2%
	Used occasionally	4.3%	27.6%	31.9%
	Used frequently	8.7%	3.4%	11.1%
	Always used	30.4%	17.2%	9.7%

Comment: Each of the lecture theatres surveyed in 1995 had a PC installed while in 1994 only one of the 15 theatres surveyed had a PC installed. These results reveal a steady increase in the use of the PC in teaching large groups once the PC is installed permanently in the MELT.

It is strange that some lecturers were unaware that a PC was installed in the lecture theatre they used during 1995. In 1994 the staff claiming that they used a PC in one of the nominated theatres would have meant that in most cases they brought their own PC into the theatre and connected to the data projector. It is perhaps disappointing that the use of PC's has not increased even more despite the fact that the all the theatres surveyed in 1995 have a PC installed in the bench.

Perceived usefulness	Response	End 1995	Mid 1995	1994
Item 15 — Personal computer	Not at all useful	8.7%	7.7%	6.4%
	Slightly useful	4.3%	15.4%	20.7%
	Useful	13%	30.8%	24.6%
	Very useful	52.2%	46.2%	48%

Comment: It would seem that there has been an increase in the perceived usefulness of PC's in lecture theatres although a majority of staff do see the PC as being useful or very useful in teaching in lecture theatres. Note that in the end 1995 survey 21.7% failed to check this box on the perceived usefulness of the PC.

Item	Response	End 1995	Mid 1995	1994
Item 17 — 35 mm slide projectors	Not available	13.0%	-	-
	Never used	82.6%	71.4%	47.5%
	Used occasionally	4.3%	17.9%	39%
	Used frequently	-	7.1%	6%
	Always used	-	3.6%	7.3%

Comment: The use of 35mm slides has declined since 1994. Other data available to the Audiovisual Services Department indicated that in some lecture theatres the slide projector is very frequently used but in other theatres it is rarely used. Perhaps in certain subject areas high quality colour still images are a necessary teaching device, but in many areas they have a limited role. It is a concern that 13% of

staff teaching in the new Z block were unaware that each lecture theatre had a slide projector installed.

Perceived usefulness	Response	End 1995 Lectern	End 1995 Radio	Mid 1995 Lectern	Mid 1995 Radio	1994 Lectern	1994 Radio
Item 19 — Lectern/radio microphones	Not at all useful	13%	4.3%	11.5%	25%	9.3%	13.1%
	Slightly useful	8.7%	4.3%	15.4%	8.3%	31.3%	23.5%
	Useful	30.4%	17.4%	26.9%	16.7%	31.3%	23.6%
	Very useful	30.4%	56.5%	46.2%	50%	48.8%	56.5%

Comment: While the majority of staff perceive microphones to be useful when lecturing it is of concern that in mid 1995 about 30% of staff saw little use for this technology. By the end of 1995 this percentage had declined significantly.

Item	Response	End 1995	Mid 1995	1994
Item 21 — Handouts	Not available	8.7%	-	-
	Never used	13.0%	3.7%	2.1%
	Used occasionally	39.1%	33.3%	27.6%
	Used frequently	17.4%	18.5%	35.1%
	Always used	21.7%	44.4%	35.1%-

Comment: It is clear that handouts are a frequently used teaching aid. The following percentages on perceived usefulness also confirm that staff see handouts as valuable learning aid for the students although the use of handouts seems be declining.

Item	Response	End 1995	Mid 1995	1994
Item 22 — Touch-screen control systems.	Never used	4.3%	10%	32.2%
	Used occasionally	8.7%	6.7%	16.1%
	Used frequently	4.3%	13.3%	20.9%
	Always used	82.6%	70%	30.6%

Comment: Each of the theatres surveyed in 1995 had the touch-screen user interface for controlling the theatre technology. The theatres surveyed in 1994 had a mixture of touch-screens and button panels. The 1994 survey also specifically mentioned the AMX system which is the product name of the equipment and many staff were unaware of this fact which affected the reliability of the 1994 results.

The 1995 results show that most staff interact with the touch screen on a regular basis. It is a worry that in mid 1995 10% of staff still managed to teach in these lecture theatres without using the touch screen at all. By the end of 1995 however the vast majority of staff did use the touch screen system during their lectures. The touch screen controls virtually all features of the theatre, including the lighting. In smaller theatres however, there is a standard OHP and blackboards so it would be possible to teach in these theatres without interacting with the touch screen.

Question	Response	End 1995	Mid 1995	1994
Item 24 — Has the installation of theatre control systems, video projectors, PA systems, etc. enabled you to adopt any different teaching strategies or present information differently during your lectures?	Yes	60.9%	53.5%	53.6%
	No	39.1%	46.7%	46.3%

Comment: In each of the surveys just over half the staff who responded to the question felt that the smart lecture theatres had resulted in them doing things differently when lecturing in the space. It is of interest however that there has been little change in the responses to this question between the first two questionnaires while by the end of 1995 there had been a greater shift in attitude. It would seem appropriate that steps could be taken to encourage staff to use different strategies and present information in a different light so that a higher percentage of staff were willing to respond 'yes' to this question.

The 'yes' comments revealed several staff who said that they now used PowerPoint or used the computer to show the class software packages. Others felt they were most easily able to integrate various media into their teaching: "Now easily able to integrate video, OHP, 35 mm slides etc. into lecture format"; "All flows more smoothly": "The transition from spoken to audiovisual material is now far smoother and more professional." "Visualiser to perform in class experiments using small objects previously passed around."

There were some similar comments made in the end of 1995 survey. "Electronic visualiser permits demonstrations of small items eg flower, grasshopper"; "I have now put all my overheads on PowerPoint which makes presentations more effective + professional and access to notes for tutors etc easier"; "Easy to incorporate a variety of mediums"; "The PC with network connections allowed me to do 'live' demo's of programming concepts and examples."

Those who answered 'no' to this item generally claimed that they did not have enough time to prepare new material for use on the PC or other media.

Impact on Teaching Strategies

As might be expected when a cross tabulation was done to see if there was any correlation between years of teaching experience and attitude to the use of the educational technology, those staff who had the least experience were slightly more likely to report that the educational technology in the theatres had enabled them to change their teaching strategies. There did not seem to be any correlation between level of appointment and attitude to using technology in teaching.

Staff Training

On reviewing the outcome of these questionnaires, it became clear that if a higher percentage of staff were to adopt different teaching strategies, a more vigorous staff training program was required. It is clear that QUT has provided very little in the way of direct funding to assist academic staff develop teaching skills in using the MELT's. This need to devote resources to the training of staff has been identified in a recent article by Walter Wagner, Paul Heye and Chia-jer Tsai at Florida State University who considered inter-relatedness between the issue of institutional development, faculty development and technology and innovation. They conclude this useful study by stating "....that in order for any technology or innovation to significantly improve the learning results of higher education institutions, there will have to be strong institutional and faculty development program in place to strategically plan for, implement, disseminate and maintain that technology. Until the culture of the institution is readied by such a change, the addition of educational technologies will remain ineffective add-ons to the traditional model of instruction."[7] In recognition of this inadequacy of response by the institution to the introduction of the MELT's as part of the quality allocation to Audiovisual Services Department in 1995, a simulated lecture theatre training venue was established. In 1996 this venue has been heavily used by Audiovisual Services to instruct staff on the use of the technologies available in the MELT's. It will remain to see what influence this venue will have on this issue of changing staff's ability to use the technology effectively when teaching large classes.

Conclusion

This paper has outlined how one of the largest universities in Australia has approached the task of upgrading the physical infrastructure relating to large group teaching. The Audiovisual Services Department has played a significant role in this process with the aim of producing teaching spaces that are flexible and capable of displaying a variety of instructional media in both new and refurbished spaces. Staff use of this technology has been surveyed over an 18-month period and some

changes in the way technology is used with large classes has been observed. While the younger staff seem to adapt their teaching strategies to make use of the new technology available in the larger lecture theatres, many of the older staff, with more than 10 years' teaching experience have remained resistant to change, despite now being faced with very large classes. To ensure staff do make effective use of the technology available, much more attention must be given at QUT to staff training in effective use of the technology for large group teaching. It is naive to expect that just because computers and touch screen theatre control systems etc. are installed, that academic staff will automatically adopt new teaching strategies to make use of the available technology.

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